TECHNICAL REPORT
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AD

INVESTIGATION OF FACTORS AFFECTING THE MELT DOWN OF SOFT SERVE IMITATION ICE MILK

by
G. C. Walker
J. M. Tuomy
and
C. C. Walts

March 1971

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

Food Laboratory
FL-123

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INVESTIGATION OF FACTORS AFFECTING THE MELT DOWN OF SOFT SERVE IMITATION ICE MILK

BY

G.C. WALKER, J.M. TUOMY AND C.C. WALTS

Experimental Methods

Continuation of Experiment 7. The effect of CMC and MCC on the melt down of ice milk. Basic mix prepared in 175 pound batches. Experiment 7 was designed to decrease the amount of variation suspected when mixes were prepared in small batches. The basic mix composition was: fat, 4.1%; milk-solids-not-fat, 11.1%; sucrose, 10.0%; corn syrup (43DE), 4.0%; tween-80, 0.03%; water to bring formulation to 100%. The basic mix was prepared in 175 pound lots.

Experiment 8. The effect of CMC, MCC and draw temperature on the melt down of ice milks. The effect of various levels of CMC and MCC and draw temperatures of 19, 20, 21 and 22F on the melt down of ice milk was investigated in experiment 8. The basic mix used was similar to that used for experiment 7. The combinations of stabilizers used is shown in Table 23.

Experiment 9. The effect of MCC, gelatin and draw temperature on the melt down of ice milks. This experiment was conducted in the same manner as experiment 8 except that gelatin was substituted for CMC at the same levels. Table 26 shows the combination of MCC and gelatin used.

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FOREWORD

The U. S. Navy has changed the design of ice cream preparation facilities aboard ships thus many new vessels are equipped with soft serve "ice cream" freezers only. The result of the change is a savings in valuable space and weight. The above change created a need for dehydrated mix for preparing an acceptable soft serve "ice cream". Paste and powder mixes, designed for hardened ice cream, are unsatisfactory because they require extensive modification before they can perform as mixes for soft serve ice milk. The Navy also requested that resistance to rapid melt down be built into the product. The Navy's request is the basis for the work reported herein.

The contributions of the following former military personnel are acknowledged and appreciated: C. S. Huber, S. T. Newton, J. Tobias, C. W. Monagle, J. Helman, P. Bryan, and E. J. Braden.

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ABSTRACT

The effect of stabilizer and emulsifier combinations, portion size, type of fat, amount of fat, level of serum solids, level of sucrose, combinations of sucrose and corn syrup solids and draw temperature, on the melt down of soft serve ice milk tested under constant conditions was evaluated. A large portion size and low draw temperature caused a low melt down; whereas, increasing the levels of milk solids-not-fat and sucrose caused an increased percent of melt down. The other factors studied generally showed a lesser effect on the melt down when the percentage of variation was computed.

INTRODUCTION

The U.S. Navy expressed a desire for a soft serve ice milk that would resist rapid melt down. The mix was to be in powdered form. The conditions imposed by the Navy were stringent. The Navy required a product that would not melt down more than 15 percent in 15 minutes when the ice milk was extruded onto a hot stainless steel mess tray and served in a dining compartment with an average ambient temperature of 85 degrees Fahrenheit and a high relative humidity. These conditions were later modified by increasing the maximum amount of melt down to 20 percent.

According to Nelson and Trout (1964) high quality ice cream will show little resistance to melting when held at room temperature. Deviations from this melting quality, including excessive resistance to melting, are considered to be defects.

A considerable body of literature has been developed concerning the effects of ingredients and processing and freezing conditions on the various criteria, including melt down, used to measure the quality of ice cream. Very little of the available literature, however, deals directly with the frozen dessert commonly known as "soft serve," and a substantial amount of this "soft serve" literature concerns "soft serve ice cream" in contrast to "soft serve ice milk" which is the product commonly served at the roadside stand.

Sheuring and Rossi (1956) studied some of the problems associated with the manufacture of soft ice cream mixes. From their study they concluded that a drawing temperature of "20F" would allow a smoother product with a higher overrun to be obtained than would lower drawing temperature. These investigators found that the use of stabilizers, emulsifiers, increased levels of fat, and substitution of one-half of the sucrose with either dextrose or corn syrup solids all had an effect in obtaining a good soft ice cream. They studied 95 different mixes and concluded that an average composition of six percent or more of milk fat, nine percent of milk solids-not-fat, 15 percent of sugar solids, 0.15 percent of emulsifier and 0.40 percent of stabilizer was the best overall formula. Brown et al. (1959) determined that the substitution of glucose for part of the sucrose did not greatly alter the melt down of soft serve or hardened ice milks. Lombard (1965) obtained a soft frozen product with a stiff body, smooth texture and glossy appearance with a mix composed of five percent fat, 12.1 percent milk solids-not-fat, 10 percent sucrose, 4 percent maise syrup solids, 0.9 percent stabilizer-emulsifier and 0.05 percent calcium sulfate. Ciobanu et al. (1962) found that decreasing the levels of nonfat dry milk increased the melt down rate of low-fat products while increasing the overrun decreased the rate of melt down. Other reported studies concerning the conditions causing the churning of milk fat in soft serve ice cream, are not germane to this research report because a lower fat level is employed in the current work than was used in the studies of fat churning.

All 50 states, the District of Columbia and Puerto Rico allow the production of ice milk. The minimum milk fat content ranges from 2.0 to 4.0 percent and the maximum from approximately 5.0 to 10.0 percent. Only 16 states and Puerto Rico allow a non-milk fat low fat frozen item to be manufactured.

In this research a fat content of four to six percent is used because this is within the fat range specified in Definitions and Standards for Frozen Desserts for ice milk (1964). Coconut fat was used because it was readily available and could be purchased in large enough lots to prevent excessive variation in composition as might be experienced with a milk fat source. However, the use of coconut fat makes the product studied an imitation ice milk.

The term "ice milk" is used as synonymous with "soft serve imitation ice milk" in this report, except for data reported as experiment 1 in which fat was obtained from a dairy products source.

EXPERIMENTAL METHODS

Experiment 1 - Preliminary investigation. Thirty-six mixes were prepared and tested in the preliminary trials comprising experiment 1. Table 1 lists the ingredients used and any characteristics pertinent to the identification of the materials. Tables 2 and 3 shows the mix formulas and the results of the tests. The mixes were prepared by pasteurizing the liquid slurry of ingredients at 165^{o}F for 30 minutes followed by homogenization at 2500 lbs per square inch (psi) then cooling to 50^{o}F. During the test period, May to October, the ambient temperature of the laboratory varied between 76 and 90F and the relative humidity between 12 and 80%. No attempt was made to control these factors. The ice milk was extruded into a standard stainless steel mess tray that had been heated in hot water and dried just prior to sampling. The pile of ice milk was allowed to sit under the ambient conditions of the laboratory for the 15-minute test period. After 15 minutes had elapsed the unmelted ice milk was removed and weighed then the melted portion was weighed. The percent meltdown (M.D.) was calculated by the formula:

$$\%M.D. = \frac{B}{A + B} \times 100 \qquad (1)$$

where A is the weight of the unmelted portion and B is the weight of the melted portion. A portion of frozen ice milk was used for measuring the temperature of the product as drawn from the freezer.

Experiment 2. - The effect of combinations and levels of stabilizers and emulsifiers and portion size on the melt down of ice milks. Experiment 2 investigated 48 combinations and levels of stabilizers and emulsifiers. The basic mix composition was: fat, 6.0%; milk, solids-not-fat, 13.0%; sucrose, 12.0%; vanillin, 0.1%; stabilizers and emulsifiers, (see Table 7); water to bring formulation to 100%. The mixes were prepared individually in 20-lb batches. Each mix was pasteurized at 155^{o}F for 30 minutes then homogenized with a two-stage homogenizer using 2000 psi on the 1st stage and 500 psi on the 2nd stage. The mixes were prepared in random order. Triplicate melt down tests were conducted with one-half and one-cup portion sizes. The viscosity of the mix was measured using a Brookfield Viscometer. The percent overrun was calculated.

For the melt down test the samples were drawn from the freezer into standard oval shaped kitchen measuring cups then transferred to a glass dish, and placed in a room controlled at 72°F and 10-12% relative humidity. The initial weight of the sample was determined and the weight of the unmelted portion after the 15 minute test period. The percent of melt down was calculated using the following formula:

$$\% \text{ M.D.} = \frac{A + B}{A} \text{ X } 100 \qquad (2)$$

where A is the weight of frozen ice milk drawn from the freezer and B is the weight of frozen ice milk remaining after 15 minutes. A portion of frozen ice milk was used for measuring the temperature of the product as drawn from the freezer.

Experiment 3 - The effect of three types of fat and two levels of milk solids-not-fat on the melt down of ice milk. Table 10 shows the formulas of mixes containing three types of fat and two levels of milk solids-not-fat used in experiment 3. The mixes for this experiment and experiments 4, 5, and 6 were prepared in 20-pound batches, and pasteurized, and homogenized as shown for experiment 2. The overrun and temperature of the frozen ice milk were determined for each mix tested in each experiment. Seven samples were drawn in quick succession into 4-ounce paper cups. The samples were leveled and then transferred to the controlled temperature and humidity room previously noted. Each sample was weighed then a hole was punched in the bottom of the cup and the ice milk transferred to a dish by gently blowing the sample out. After the 15-minute test period the unmelted portion was weighed and the two weights were used to calculate the melt down by formula 2. The initial weight was corrected for the tare of the cup.

Experiment 4 - The effect of three types of fat and two levels of sucrose on the melt down of ice milks. Experiment 4 tested the effect of 100-hour shortening, corn oil and cottonseed oil flakes and two levels of sucrose on the melt down of soft serve ice milk. Table 12 shows the formulas of the mixes. Five replicates were tested for melt down using the method described for experiment 3.

Experiment 5 - Investigation of levels of coconut fat, sodium carboxymethyl cellulose and microcrystalline cellulose on the melt down of ice milk. Three levels each of coconut fat, sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) were tested for their influence on melt down in experiment 5. The basic mix composition was: milk solids-not-fat, 11.2%; sucrose, 11.0%; corn syrup (43DE), 4.0%; vanillin, 0.04%; Tween-80, 0.03%; water to bring formulation to 100%. The combinations and percentages of coconut fat, CMC and MCC are shown in Table 14. Five replicates were tested for melt down by the technique previously described.

Experiment 6 - Investigation of the effect of CMC and MCC on the melt down of ice milks. Experiment 6 employed a basic mix similar to that used in experiment 5, except that 4.0% coconut fat was used. The levels of CMC and MCC used are shown in Table 17. Five replicates were tested.

Experiment 7 - The effect of CMC and MCC on the melt down of ice milk. Basic mix was prepared in 175 pound lots. The hot mix was drawn off in 24 pound batches and 16-ounces of sucrose, containing the percentages of CMC and MCC shown in Table 20 plus the vanilla flavoring, was mixed into the hot liquid. Five replicates were tested for melt down.

Experiment 10 - The effect of MCC, algin and draw temperature on the melt down of soft serve ice milk. Experiment 10 is similar to experiments 8 and 9 except that algin was substituted for CMC at the same levels. Table 29. shows the combinations of MCC and algin used.

Experiment 11 - The effect of low dextrose equivalent corn syrup solids and draw temperature on the melt down of ice milks. Experiment 11 was designed to test the phenomenon that certain amounts of low dextrose equivalent corn syrup solids will cause an increase in the resistance to melting of ice cream. The basic mix composition was: fat, 4.1%; milk, solids-not-fat, 11.1%; sweetener, 15.0%; CMC, 0.5%; Tween-80, 0.03%; vanillin, 0.03%; water, 69.24%. The sweetener combinations are shown in Table 32. Five replicates were tested for melt down.

Analysis of data. The melt down data from experiments 2 through 11 was analyzed by a standard analysis of variance procedure. The results of the analysis of variance were further analysed by the components of variance test described by Hicks (1956). Linear correlations were determined for draw temperature, percent overrun and percent melt down.

RESULTS AND DISCUSSION

Experiment 1 - Preliminary investigations. An analysis of variance was not made of the data obtained from experiment 1. The results (Tables 4 and 5) show that the melt down of the samples ranged from 9.0 to 58.8%. Thirty-two of the 33 mixes (97%) tested showed over 20% melt down, 5 mixes (15%) had over 40% melt down. The draw temperature ranged from 18 to 25F and the overrun ranged from 20 to 60%. Correlation coefficients for draw temperature, percent melt down and percent overrun are shown in Table 6. The lack of significant correlation between the draw temperature and percent melt down is probably because of the variability in the ambient temperature and relative humidity of the area in which the melt down test was conducted. The correlation between percent overrun and percent melt down while significant is low.

Experiment 2 - The effect of combinations and levels of stabilizers and emulsifiers and portion size on the melt down of ice milks. Table 7 shows the results of the experimentation and Table 8 shows the statistical analysis of the data for melt down obtained in experiment 2. As noted from Table 8, the size of the serving portion contributes the bulk of the variation. Emulsifiers contributed more to the variance than did the stabilizers. The average melt down was 13% for the 1 cup portions and 17.9% for the 1/2 cup portions. The range of the average melt down values was 8.7 to 18.1% for the 1 cup portion and 7.7 to 23.7% for the 1/2 cup portion.

The data indicates that all of the emulsifiers were functioning to about the same degree. Bassett (1958) recommends a combination of monoglyceride and "poly" type emulsifiers to achieve a soft serve product with a dry appearance which indicates resistance to melting. The results of this experiment indicate no advantage in using a combination of emulsifiers over the use of

"polys" alone. When the data for the stabilizers was examined an average melt down of 13.2% for the 1 cup portion with a range of 12 to 14% and an average meltdown of 17% for the 1/2 cup portion with a range of 16 to 20% could be calculated. No one of the stabilizers tested showed any advantage in its use over any of the others tested. Table 9 shows only one significant correlation; between the draw temperature and the percent overrun. The effect of the freezing temperature on the overrun is well recognized. Sommer(1951) and Turnbow, Tracy and Raffetto(1947) discuss the subject of overrun at great length. The viscosities of the mixes varied from 20 to 1,000 centipoises at a speed of 20 rpm and spindle 3. No trouble was experienced with any of the mixes in flow of product from the supply hopper, through a narrow diameter tube, to the freezing cylinder.

Experiments 3 and 4 - The effect of three types of fat and two levels of milk solids-not-fat or sucrose on the melt down of ice milks.

Tables 10 and 11 show the percent overrun, draw temperature and average percent melt down for experiments 3 and 4 respectively. Tables 12 and 13 show the statistical analysis of the data obtained for melt down for experiments 3 and 4, respectively.

Tables 12 and 13 indicate that although the type of fat used in the mix was a significant factor in the variance of the results the milk solids-not-fat and sucrose contributed approximately 2 and 5 times more to the variance, respectively, than did the fat. Examination of the data in Table 10, for experiment 3 shows the mixes containing 100-hour shortening or corn oil had average melt down values of about 21 and 19% respectively, whereas, the mix containing cottonseed oil flakes had an average melt down of 25%. The mixes containing the lower amount of milk solids-not-fat also had the lowest average percent melt down. The data for experiment 4 (Table 11) indicates the same trend with the lower level of sucrose giving a product with a lower melt down. Throughout experiments 3 and 4 the draw temperature was the same. The increased meltdown, under the same conditions, of ice milk containing the higher levels of milk solids-not-fat or sucrose may be attributed to the increase in the amount of solute. The freezing point of the mix was lowered. The draw temperature remained the same, therefore, less of the water in the product was frozen which led to an increased rate of melt down. No correlation between the draw temperature and the percent melt down or overrun was possible because the draw temperature was the same in all instances. The correlation between the percent overrun and percent melt down was not significant in either experiment.

Experiment 5 - Investigation of levels of coconut fat, sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose(MCC) on the melt down of ice milks. Table 14 shows the percent overrun, draw temperature and average percent melt down and Table 15 shows the statistical analysis of the results. In this experiment the use of sodium carboxymethyl cellulose (CMC) had no significant effect on the melt down of the ice milk. Examination of the data shows an average melt down of 11.3 to 11.9% in ice milk containing CMC. In ice milk containing microcrystalline cellulose (MCC), however, average melt

down values were 10.9, 11.3 and 12.5% with decreasing amounts of stabilizer. Although the amount of fat had a significant effect on the variance, no trend was evident when the data was examined. Melt down values averaged 12, 12 and 11% with increasing amounts of fat in the mix. Correlations were determined between draw temperature, percent overrun and percent melt down. The results of the correlation test are shown in Table 16. A low degree of correlation was obtained between the percent overrun and percent melt down.

Experiment 6. - Investigation of the effect of CMC and MCC on the melt down of ice milks. Table 17 shows the percent overrun, draw temperature, and average percent melt down obtained when various levels of MCC and CMC were tested for their effect on melt down of soft serve ice milk. Table 18 shows the statistical analysis of the data shown in Table 17 which was obtained for melt down for the mixes tested in experiment 6.

The data (Table 17) shows that the average melt down decreases when the level of CMC increases. The same tendency is not evident with increasing levels of MCC. The data (Table 18) shows that the use of CMC contributed more than three times as much to the variance than did the use of MCC. A correlation test between the draw temperature, percent overrun and percent melt down was conducted. The results of the correlations are shown in Table 19.

Experiment 7 - The effect of CMC and MCC on the melt down of ice milks. Basic mix prepared in 175 pound batches. The ice milk mixes used in the previous experiments reported herein were prepared in small batches. As indicated in the experimental procedures the basic mixes used in experiment 7 and subsequent experiments were prepared in large amounts to minimize the errors inherent in small batch preparation.

Table 20 shows the percent overrun, draw temperature and average percent melt down obtained when various combinations of CMC and MCC were listed. Table 21 shows the statistical analysis of the data obtained for melt down for the mixes tested in experiment 7. The data in Table 20 for melt down and overrun shows no identifiable trend with increasing levels of either CMC or MCC. The average melt down ranged from 4.5 to 14.5%. Twenty-two (61%) samples had less than 10% melt down. The statistical analysis (Table 21) shows that about 2/3 of the variance is attributable to CMC. A positive significant correlation was found between the draw temperature and the percent melt down ($P > 0.01$), and the percent overrun ($P > 0.05$), (Table 22).

Experiment 8 - The effect of CMC, MCC and draw temperature on the melt down of ice milk. The influence of the draw temperature on the resistance to melt down was noted when mixes with the same source of raw ingredients, composition and processing were compared. At draw temperatures of 20,20.5, and 23F; 8.7, 9.5 and 23.8% melt down, respectively was noted. Table 23 shows the percent overrun, and average percent melt down obtained when various combinations of CMC and MCC were tested for their effect on the melt down of soft serve ice milk drawn from the freezer at 19, 20, 21 and 22F. Table 24 shows the statistical analysis of the data obtained for melt down for the mixes tested in

experiment 8.

The effect of draw temperature on overrun and melt down can be seen in Table 23. The draw temperature contributed 10 and 17 times more to the variance than did the MCC and CMC, respectively. The results of the correlation test between draw temperature and percent overrun and percent overrun and percent melt down is shown in Table 25.

Experiment 9 - The effect of MCC, gelatin and draw temperature on the melt down of ice milks. Table 26 shows the percent overrun, and average percent melt down obtained at draw temperatures of 19, 20, 21 and 22F when combinations of MCC and gelatin were tested. Table 27 shows the statistical analysis of the melt down data for the mixes tested. The data show that in general the average percent melt down was lower at each draw temperature when higher levels of gelatin and MCC were used. However, the statistical analysis (Table 27) shows that almost half of the variance was attributable to the effect of gelatin, while the effect of MCC was responsible for less than 1/5 of the variance. The effect of draw tempeature was approximately 3 times greater in experiment 8 than in experiment 9. Table 28 shows the results of the correlation test between draw temperature, percent overrun and percent melt down.

Experiment 10 - The effect of MCC, algin and draw temperature on the melt down of ice milks. The percent overrun and average percent melt down obtained when the effect of three levels of MCC and algin were tested at draw temperature of 19, 20, 21 and 22F are shown in Table 29. The data shows that algin has no significant effect in the melt down and that MCC has only a small effect. Table 30 shows the results of the statistical analysis of the melt down data. As seen from the table the draw temperature had the greatest influence on the variation. The correlation between draw temperature, percent overrun and percent melt down are shown in Table 31.

Experiment 11 - The effect of low dextrose equivalent corn syrup solids and draw temperature on the melt down of ice milks. Mahdi and Bradley (1968) noted that the "does not melt" defect could be obtained when excess amounts of low dextrose equivalent (DE) corn syrup solids were used. Experiment No. 11 was designed to see if this "defect" could be used to advantage. Table 32 shows the percent overrun and average percent melt down at draw temperatures of 19, 20, 21 and 22F. Table 33 shows the major influence on the melt down was the draw temperature. The sweetener combinations used contributed only a minor portion of the variance. In this experiment the amount of substitution was confined to 25% of the total amount of sweetener because of flavor problems associated with the use of large amount of corn syrup solids. The correlation coefficients for draw temperature, percent overrun and percent melt down are shown in Table 34.

CONCLUSIONS

1. Portion size and draw temperature causes reduction in the percent melt down under the conditions used.

2. Increasing the level of sucrose on milk solids-not-fat causes the percent melt down to increase because of a solute effect.

3. Carboxymethyl cellulose influences melt down to a greater extent than microcrystalline cellulose by effecting a reduced melt down as the level of CMC increases.

4. The use of a combination of monoglycerides and "poly" type emulsifiers had no advantage over "poly" type emulsifier used alone.

5. The use of low DE corn syrup solids has no apparent effect on the melt down when used within the guide lines of not more than 25% replacement of the total sweetener.

6. A product meeting the requirements was not produced. Further investigation using other ingredients and additives could possibly produce the product the Navy wants but we doubt the investment in time and funds would be justified.

Table 1. List and composition of ingredients used in ice milk mixes in Experiment 1.

Ingredient	Composition
Cream	30% milk fat
Evaporated skimmed milk	27% serum solids
Nonfat dry milk	low heat
Sodium casienate	
Sucrose	
Corn syrup solids	36 Dextrose equivalent (DE)
Sodium carboxymethyl cellulose	High viscosity
Dariloid XL	Milk soluble algin (with sodium phosphate and dextrin)
Drikoid KB	Propylene glycol alginate, locust bean gum, guar gum, carrageenan, mono-and di-glycerides, polysorbate 80 (6.2%), sugar, and sodium silico-aluminate
Irish moss	Extract of Irish moss plant (chondus crispus)
Sodium alginate	

Table 1. (Continued) List and composition of ingredients used in ice milk mixes in Experiment 1.

Ingredient	Composition
Microcrystalline cellulose	
Starch	Instant clear jel
Starch	National starch #1413
Gelatin	270 bloom
Guar gum	From guar seed (cyamopis tetragonalobus)
Atmos 300	mono- and - di-glycerides plus 0.01% of butylated hydroxyanisole, butylated hydroxytoluene and citric acid in propylene glycol
Mono-and di-glycerides	Distilled mono- and di-glycerides (80%) hydrogenated vegetable oil (20%) plus butylated hydroxyanisole (0.16%), propyl gallate (0.016%), citric acid (0.008%), glycine (0.011%), phosphoric acid (0.011%).
Tween - 80	
Tween-mos 100	Mono- and di-glycerides (80%) and polysorbate 80 (20%).
Germantown emulsifier	No. 76

Table 2. Composition of ice milk mixes 1 to 18 for experiment 1.

Ingredient	MIX NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17 2/	18
Cream	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75		6.75
Evaporated Skimmed Milk	14.3	12.75	12.75	12.75														
Nonfat dry milk					3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.85	4.25	4.25	4.25	4.31		4.55
Sodium Casienate		0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675						
Sucrose	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95	5.40		5.40
Corn Syrup Solids																0.90		0.90
Clear Jel Starch, Instant																		
Starch #1413																		
Dariloid-XL					0.135	0.135	0.18	0.18										
Dricoid-KB									0.18	0.216	0.216	0.216						
Irish Moss	0.045		1.04/	1.14/												0.0045		0.0045
Sodium Alginate		0.225																

Table 2 (continued) Composition of ice milk mixes 1 to 18 for experiment 1

	MIX NUMBER																	
Ingredient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	2/ 17	18
Microcrystalline Cellulose													0.35	0.35	0.18			0.665
Sodium Carboxymethyl Cellulose	0.16		4/ 3.25	4/ 4.04												0.45		0.0045
Gelatin																		
Guar Gum																		
Atmos - 300																		
Mono - And Di-Glycerides	0.027					0.36	0.36	0.36						0.045				
Tween-80																		
Germantown #76			5/ 10	4/ 0.36														
Tween Mos 100 VS													0.045		0.034	0.034		0.0339
Atmos-150																		
Water	18.55	19.50	19.50	19.50	28.60	28.60	28.60	28.60	28.60	28.60	28.60	28.60	28.67	28.67	28.73	[illegible]		26.21

12

Table 3. Composition of ice milk mixes 19 to 36 for experiment 1

Ingredient	MIX NUMBER 19	20 2/	21	22	23 3/	24	25	26 2/	27	28 2/	29	30	31	32	33	34	35	36 8/
Cream	6.75		6.75	6.75		6.75	6.75								3.72	3.72	3.72	3.72
Evaporated Skimmed Milk																		
Non Fat Dry Milk	5.02		5.02	5.02		5.02	5.50		5.50						1.83	1.83	1.83	1.83
Sodium Casienate																		
Sucrose	5.175		4.95	4.95		4.95	4.95		4.95						2.49	2.49	2.49	2.49
Corn Syrup Solids	1.80		1.80	1.80		1.80	1.80		1.80									
Clear Jel Starch, Instant															5/ 272			
Starch #1413																	5/ 181.6	
Dariloid-XL																		
Dricoid-KB																		
Irish Moss	0.0045		0.0045	0.0045		0.0045	0.0045		0.0045			0.002	0.001	0.0016	0.003	0.003	0.003	0.003
Sodium Alginate																		

Table 3 - Composition of ice milk mixes 19 to 36 for experiment 1. (cont'd)

Ingredient	MIX NUMBER 19	20 2/	21	22	23 3/	24	25	26 2/	27	28 2/	29	30	31	32	33	34	35	36 8/
Microcrystalline Cellulose	0.3375		0.3375	0.3375		0.3375	0.225		0.225									
Sodium Carboxy-methyl Cellulose	0.045		0.045	0.045		0.045	0.045		0.045		0.009	0.01	0.006	0.008	0.029	0.029	0.029	0.029
Gelatin																90.8 5/		
Guar Gum												0.01	0.006	0.008	0.029	0.029	0.029	0.029
Atmos-300									16.3 5/									
Mono-and Diglycerides																		
Tween-80						4.3 5/			14.3 5/						0.015	0.015	0.015	0.015
Germantown #76 Emulsifier																		
Tween mos-100 VS	0.0337		0.0337	0.0675		0.0675	0.0675		0.0675						0.023	0.023	0.023	0.023
Atmos - 150																		
Water	25.84		26.06	26.06		26.06	25.66		25.66									
Basic Mix 1/												4.5	4.5	4.5	4.5	11.85	11.85	11.85

TABLE 4 - The percent overrun (O.R.) draw temperature (F) and Percent melt down (M.D.) for ice milk tested for experiment 1 (Mixes 1 to 18)

	MIX NUMBER																	
RESULTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17 2/	18
% O.R.	38.0	48.0				45.0	42.0	41.0	37.0	40.5	36.0	33.0	35.1		34.9	35.2	60.0	37.8
Draw Temp ^{o}F	21.8	23.0	6/	6/	22.5	22.5	22.0	22.8	21.8	22.8	22.0	21.8	21.8	7/	20.6	21.4	25.0	20.3
% M.D.	28.0	33.0			23.2	23.5	33.0	50.0	28.0	9.0	27.0	30.0	27.2		40.6	36.0	34.4	37.9

Table 5. The percent overrun (O.R.) draw temperature (F) and percent melt down (M.D.) for ice milks tested for experiment 1. (Mixes 19 to 36)

	MIX NUMBER																	
RESULTS	19	20 2/	21	22	23 3/	24	25	26 2/	27	28 2/	29	30	31	32	33	34	35	36 8/
% O.R.	34.2	53.6	37.2	37.2	37.2	45.0	34.2	53.6	34.0	45.8	31.0	32.5	26.4	27.0	20.0	30.0	43.0	32.0
°F Draw Temp	21.0	24.0	21.0	21.0	18.0	19.0	21.0	24.0	19.0	22.0	19.0	22.0	19.0	19.0	-	21.4	21.0	22.5
% M.D.	32.4	39.5	46.9	46.9	38.0	32.0	32.4	39.5	37.8	36.6	58.8	33.3	30.0	37.3	26.0	21.0	22.0	33.7

FOOT NOTES APPLICABLE TO TABLES 2,3,4 and 5

1/ Basic mix formula: dehydrated ice cream mix, 1.0 pounds; nonfat dry milk, 0.265 pounds; sucrose, 0.190 pounds; water, 3.045 pounds.

2/ Same formula as preceeding mix. The draw temperature, percent overrun and percent melt down were measured after 20 servings had been drawn from the freezer.

3/ Same formula as preceeding mix. The draw temperature, percent overrun and percent melt down were measured after 12 servings had been drawn from the freezer.

4/ Ounces of ingredient.

5/ Grams of ingredient.

6/ Mix was to viscous to feed properly.

7/ Over emulsification caused mix to separate.

8/ An additional 21.25 grams (g.) of sodium carboxymethyl cellulose, 21.25 g. of guar gum, and 2.82 g. of Irish moss was mixed with 86 g. of sucrose and was added to the mix.

Table 6. Correlation coefficients (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 1.

Correlation Factors	r
Draw temperature/percent overrun	0.781**
Draw temperature/percent melt down	0.241 n.s.
Percent overrun/percent melt down	0.364*

*p> 0.05 0.349 **p> 0.01 0.449 n.s -not significant

Table 7. Combinations and amounts of stabilizers and emulsifiers in 48 ice milk mixes. The percent overrun (O.R.), draw temperature (F) and average percent melt down (M.D.) for 1/2 and 1-cup portion sizes for ice milks tested for experiment 2

		Stabilizers							
Emulsifiers	Parameters Measured	Irish Moss 13.6g.	Gum Tragacanth 13.6g.	Gum Arabic 13.6g.	Guar Gum 13.6g.	Dariloid-XL 32.7g.	Dricoid-KB 34.5g.	CMC-HV 7/ 9.1g.	CMC-MV 7/ 15.4g.
TweenMos - 280 VS 1/ 22.7g.		Mix No. 1	Mix No. 7	Mix No. 13	Mix No. 19	Mix No. 25	Mix No. 31	Mix No. 37	Mix No. 43
	% O.R.	45.8	59.1	50.0	52.2	25.9	59.1	50.0	45.8
	Draw Temp	18	-	18	-	19	20	18	19
Tween-80 2/ 2.7g.	% M.D.: 1/2-cup	15.1	20.5	15.4	13.0	21.4	23.1	20.0	17.9
	1-cup	8.7	15.1	15.0	11.9	14.5	9.5	12.7	14.8
TweenMos -100 VS 3/ 13.6g.		Mix No. 2	Mix No. 8	Mix No. 14	Mix No. 20	Mix No. 26	Mix No. 32	Mix No. 38	Mix No. 44
	% O.R.	45.8	45.8	52.2	52.2	45.8	45.8	59.1	59.1
	Draw Temp	19	20	19	19	19	20	-	20
	% M.D.: 1/2 cup	15.4	18.0	21.2	31.8	23.7	21.0	20.5	12.4
	1-cup	14.4	12.6	16.1	13.0	13.1	18.1	13.9	16.0
TweenMos -240 VS 4/ 22.7g.		Mix No. 3	Mix No. 9	Mix No. 15	Mix No. 21	Mix No. 27	Mix No. 33	Mix No. 39	Mix No. 45
	% O.R.	45.8	45.8	59.1	52.2	45.8	45.8	52.2	52.2
Tween-80 2.7g.	Draw Temp	20	18	20	20	19	20	19	19
	% M.D.: 1/2-cup	12.8	18.3	19.4	15.4	12.5	23.1	15.4	13.6
	1-cup	9.5	10.0	10.8	13.1	14.3	17.6	16.4	13.0
Tween-80 2.7g.		Mix No. 4	Mix No. 10	Mix No. 16	Mix No. 22	Mix No. 28	Mix No. 34	Mix No. 40	Mix No. 46
	% O.R.	45.8	37.0	59.1	45.8	37.0	29.6	52.2	45.8
	Draw Temp	18	18	-	-	19	18	-	19
	% M.D.: 1/2-cup	23.7	13.5	14.7	20.9	20.9	15.4	22.5	17.4
	1-cup	11.2	13.7	14.0	12.7	12.7	12.1	13.0	15.3
Tween-65 5/ 6.3g.		Mix No. 5	Mix No. 11	Mix No. 17	Mix No. 23	Mix No. 29	Mix No. 35	Mix No. 41	Mix No. 47
	% O.R.	29.6	34.6	45.8	66.7	45.8	52.2	45.8	45.8
	Draw Temp	18	20	18	22	18	19	18	19
	% M.D.: 1/2-cup	14.8	15.4	20.5	7.7	14.5	21.4	12.4	17.6
	1-cup	13.5	12.0	9.8	12.6	16.7	11.7	13.0	14.0
Tween-80 2.7g.		Mix No. 6	Mix No. 12	Mix No. 18	Mix No. 24	Mix No. 30	Mix No. 36	Mix No. 42	Mix No. 48
	% O.R.	45.8	52.2	45.8	56.5	45.8	45.8	56.5	52.2
Tween-65 6.3g.	Draw Temp	-	-	20	19	-	20	19	19
	% M.D.: 1/2-cup	11.1	20.5	23.1	14.3	17.4	15.8	20.5	23.1
	1-cup	13.9	13.6	12.5	10.3	11.3	11.6	12.8	11.6

FOOT NOTES APPLICABLE TO TABLE 7

1/ Mono-and-di-glycerides, 60%; polyoxyethylene 20 sorbitan tristerate, 40%

2/ Polyoxyethylene (20) sorbitan monooleate.

3/ Mono-and di-glycerides, 80%; polysorbate 80, 20%.

4/ Mono-and di-glycerides, 80%; polyoxyethylene 20 sorbitan tristearate, 20%.

5/ Polyoxyethylene (20)sorbitan tristearate

6/ Sodium carboxymethyl cellulose, high viscosity.

7/ Sodium carboxymethyl cellulose, medium viscosity.

Table 8. Analysis of variance and percentage of variation for the effect of stabilizers, emulsifiers and portion size on the melt down of ice milks tested for experiment 2.

Source of Variance	Analysis of Variance	Percentage of variation
Stabilizers	*	3.6
Emulsifiers	**	8.1
Portion Size	**	87.3
Stabilizer-emulsifier interaction	**	0.6
Stabilizer-portion size interaction	n.s.	-
Emulsifier-portion size interaction	n.s.	-
3-Factor interaction	**	0.3
Not accounted for	-	0.1

*p> 0.05 **p> 0.01 n.s. - not significant

Table 9. Correlation coefficients (r) for draw temperature percent overrun, percent melt down and mix viscosity of ice milks tested for experiment 2.

Correlation Factors	r	d.f.
Mix viscosity/Ave. percent melt down 1/	-0.127 n.s.	46
Mix viscosity/Ave. percent melt down 2/	-0.108 n.s.	46
Draw temp./Ave. percent melt down 1/	-0.098 n.s.	38
Draw temp./Ave. percent melt down 2/	0.070 n.s.	38
Draw temp./percent overrun	0.443**	38

**p 0.01 n.s. - not significant

0.393

1/ 1/2- cup portion size

2/ 1-cup portion size

Table 10. Composition of 6 ice milk mixes containing three types of fat and two levels of milk solids-not-fat. The percent overrun (O.R.), draw temperature (F) and average percent melt down (M.D.) for ice milks tested for experiment 3.

	Percent of Ingredient in Mix No.					
Ingredient	1	2	3	4	5	6
100-hour shortening	6.1			6.1		
corn oil		6.1			6.1	
Cottonseed oil flakes			6.1			6.1
Milk solids-not-fat	15.1	15.1	15.1	17.1	17.1	17.1
Sucrose	12.0	12.0	12.0	12.0	12.0	12.0
Vanillin	0.04	0.04	0.04	0.04	0.04	0.04
Irish moss	0.15	0.15	0.15	0.15	0.15	0.15
Tweenmos -280VS	0.25	0.25	0.25	0.25	0.25	0.25
Tween-80	0.03	0.03	0.03	0.03	0.03	0.03
Water	66.33	66.33	66.33	64.33	64.33	64.33
% O. R.	36.0	33.3	36.0	40.0	28.6	35.9
Draw Temperature	18	18	18	18	18	18
% M.D.	18.5	15.9	23.5	22.9	22.0	26.5

Table 11. Composition of 6 ice milk mixes containing three types of fat and two levels of sucrose. The percent overrun (O.R.), draw temperature (F) and average percent melt down (M.D.) for ice milks tested for experiment 4.

	Percent of Ingredient in Mix No.					
	1	2	3	4	5	6
100-hour shortening	6.1			6.1		
Corn Oil		6.1			6.1	
Cottonseed oil flakes			6.1			6.1
Milk solids-not-fat	13.1	13.1	13.1	13.1	13.1	13.1
Sucrose	13.5	13.5	13.5	15.0	15.0	15.0
Vanillin	0.04	0.04	0.04	0.04	0.04	0.04
Irish moss	0.15	0.15	0.15	0.15	0.15	0.15
Tweenmos - 280VS	0.25	0.25	0.25	0.25	0.25	0.25
Tween-80	0.03	0.03	0.03	0.03	0.03	0.03
Water	66.83	66.83	66.83	65.33	65.33	65.33
% O.R.	59.1	25.0	50.0	52.2	29.6	40.0
Draw Temperature	18	18	18	18	18	18
% M.D.	13.8	12.4	17.1	20.2	17.4	21.4

Table 12 - Analysis of variance and the percentage of variation for the effect of type of fat and levels of milk solids-not-fat on the melt down of ice milks tested for experiment 3.

Source of Variance	Analysis of Variance	Percentage of Variation
Type of Fat	**	31.3
Levels of Milk Solids-not-fat	**	68.6
Interaction	n.s.	-
Not accounted for	-	0.1

**p> 0.01 n.s. - not significant

Table 13. Analysis of variance and the percentage of variation for the effect of type of fat and levels of sucrose on the melt down of ice milks tested for experiment 4.

Source of Variance	Analysis of Variance	Percentage of Variation
Type of Fat	**	16.9
Levels of Sucrose	**	83.0
Interaction	n.s.	-
Not Accounted for	-	0.1

**$p > 0.01$ n.s. - not significant

Table 14. Combinations of coconut fat, sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) used in 27 ice milk mixes. The percent overrun (O.R.), draw temp (F) and average percent melt down (M.D.) for ice milks tested for experiment 5

% CMC	% MCC	Parameters Measured	% Coconut Fat 2	% Coconut Fat 4	% Coconut Fat 6
0.3	1.2	% O.R.	33.9	54.1	33.3
		Draw Temp	19.5	21.0	20.5
		% M.D.	10.0	13.0	12.7
	1.3	% O.R.	36.4	25.4	29.8
		Draw Temp	18.5	20.5	19.6
		% M.D.	9.6	12.8	9.2
	1.4	% O.R.	63.0	51.1	27.1
		Draw Temp	21.0	20.5	21.0
		% M.D.	11.0	14.1	9.3
0.4	1.2	% O.R.	53.2	43.5	27.1
		Draw Temp.	21.0	21.0	20.5
		% M.D.	14.2	14.5	12.7
	1.3	% O.R.	41.5	58.7	42.0
		Draw Temp	19.7	21.5	21.0
		% M.D.	8.8	13.4	13.7
	1.4	% O.R.	46.0	31.6	21.0
		Draw Temp	20.5	18.0	20.5
		% M.D.	13.8	9.2	9.0
0.5	1.2	% O.R.	57.4	48.0	30.9
		Draw Temp	21.5	21.5	20.5
		% M.D.	12.1	12.2	10.9
	1.3	% O.R.	62.2	25.9	22.6
		Draw Temp	21.0	21.0	20.5
		% M.D.	13.0	12.9	10.6
	1.4	% O.R.	60.9	38.9	44.0
		Draw Temp	19.5	20.5	20.0
		% M.D.	11.5	9.5	10.4

Table 15. Analysis of variance and percentage of variation for the effect of levels of coconut fat, sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) on the melt down of ice milks tested for experiment 5.

Source of Variance	Analysis of Variance	Percentage of Variation
Levels of Coconut fat	**	30.5
Levels of CMC 1/	n.s.	-
Levels of MCC 2/	**	44.5
Fat-CMC Interaction	**	8.9
Fat-MCC Interaction	**	6.9
CMC-MCC Interaction	**	7.2
3 Factor Interaction	**	2.0
Not Accounted For	-	<0.1

** $p > 0.01$ n.s. - not significant

Table 16. Correlation coefficients (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 5.

Correlation Factors	r	d.f.
Draw temp./Ave. Percent meltdown	0.585**	26
Draw temp./Percent overrun	0.313 n.s.	26
Percent overrun/Percent melt down	0.428*	26

*p > 0.05
0.374

**p > 0.01
0.478

n.s. -not significant

Table 17. Combinations of sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) used in 9 ice milk mixes. The percent overrun (O.R.), draw temperature (F) and average percent melt down (M.D.) for ice milks tested for experiment 6.

% CMC	Parameters Measured	% MCC		
		1.4	1.7	2.0
0.5	% O.R.	63.3	51.0	44.0
	Draw Temp	23	22.1	24.8
	% M.D.	23.8	12.1	18.5
0.7	% O.R.	32	39.6	40.7
	Draw Temp	21	20	20.5
	% M.D.	16.4	11.4	13.2
0.9	% O.R.	54.1	48.1	39.6
	Draw Temp	21	21.5	22
	% M.D.	12.3	5.8	27.0

Table 18. Analysis of variance and the percentage of variation for the effect of sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) on the melt down of ice milks tested for experiment 6.

Source of Variation	Analysis of Variance	Percentage of Variation
Levels of CMC	**	69.0
Levels of MCC	*	20.8
Interaction	**	10.0
Not Accounted For	-	0.2

* $p > 0.05$ $p > 0.01$

Table 19. Correlation coefficients (r) for draw temperature, percent overrun, and percent melt down of ice milks tested for experiment 6.

Correlation Factors	r	d.f.
Draw Temp./Percent melt down	0.396**	44
Draw Temp./Percent overrun	0.344 n.s.	8
Percent overrun/Percent melt down	0.033 n.s.	44

** p> 0.01 n.s. - not significant

0.372

Table 20. Combinations of sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) used in 36 ice milk mixes. The percent overrun (O.R.), draw temperature (F) and average percent melt down (M.D.) for ice milks tested for Experiment 7.

		% MCC					
% CMC	Parameters Measured	0.0	1.2	1.3	1.4	1.7	2.0
0.0	% O. R.	38.9	28.1	18.0	38.2	25.4	40.0
	Draw Temp	19	19	19	19	19	19
	% M.D.	8.4	8.5	7.3	6.2	7.6	8.5
0.3	% O.R.	49.0	37.7	33.9	39.7	37.7	35.8
	Draw Temp	19.5	19	20	19.5	19.8	19.5
	% M.D.	11.8	9.3	7.0	6.2	6.2	8.2
0.4	% O.R.	41.8	35.8	35.8	43.1	43.1	37.0
	Draw Temp	20	20	19.5	19.8	19.8	19.5
	% M.D.	10.1	11.6	8.3	6.7	7.8	11.3
0.5	% O.R.	39.9	37.2	37.2	30.9	30.9	41.2
	Draw Temp	20	20	20	20	20	20
	% M.D.	10.7	10.3	10.0	8.7	7.8	4.5
0.7	% O.R.	40.4	38.5	42.3	35.8	35.8	35.8
	Draw Temp	20	20	20.5	20	20	20
	% M.D.	10.0	8.3	10.4	8.8	7.9	6.7
0.9	% O.R.	70.4	36.4	32.1	36.4	32.1	38.5
	Draw Temp	21	20	20	21	20	21
	% M. D.	11.7	10.0	10.9	13.9	8.8	14.5

Table 21. Analysis of variance and percentage of variation for the effect of sodium carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) on the melt down of ice milks tested for experiment 7.

Source of variance	Analysis of variance	Percentage of Variation
Levels of MCC	*	32.8
Levels of CMC	**	63.7
Interaction	*	3.1
Not Accounted For	-	0.3

*$p > 0.05$ ** $p > 0.01$

Table 22. Correlation coefficients (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 7.

Correlation Factors	r	d.f.
Draw Temp./Percent Melt Down	0.530**	35
Draw Temp/Percent overrun	0.348*	35
Percent overrun/Percent melt down	0.270 n.s.	35

*p > 0.05 0.325   **p > 0.01 0.418   n.s.-not significant

Table 23. Combinations of sodium carboxymehtyl cellulose (CMC) and microcrystalline cellulose (MCC) and used in 9 ice milk mixes. The percent overrun (O.R.) and average percent melt down (M.D.) at draw temperatures of 19, 20, 21 and 22F for ice milks tested for experiment 8.

% CMC	Parameters Measured	% MCC											
		0.0				1.3				1.5			
		Draw Temperature				Draw Temperature				Draw Temperature			
		19	20	21	22	19	20	21	22	19	20	21	22
0.0	% O.R.	32.7	40.4	43.1	44.6	41.5	44.2	44.2	47.0	29.8	37.0	42.3	54.0
	% M.D.	9.6	13.9	16.7	23.8	6.3	9.1	13.2	22.7	7.6	8.7	12.4	19.3
0.3	% O.R.	39.6	48.0	51.0	51.0	32.7	40.4	43.1	52.1	35.2	44.2	44.2	44.2
	% M.D.	7.7	8.4	16.0	17.3	6.2	10.7	14.7	18.5	4.7	12.6	12.5	14.8
0.5	% O.R.	44.2	50.0	50.0	50.0	35.2	40.4	46.0	46.0	29.3	37.7	38.9	47.0
	% M.D.	8.0	13.2	16.3	19.3	4.7	10.1	15.4	17.6	6.2	11.7	13.9	18.5

Table 24. Analysis of variance and percentage of variation for the effect of sodium carboxymethyl cellulose (CMC), microcrystalline cellulose cellulose (MCC) and draw temperature (F) on the melt down of ice milk tested for experiment 8.

Source of Variance	Analysis of Variance	Percentage of Variation
Levels of MCC 1/	**	8.5
Levels of CMC 1/	*	4.9
Draw Temperature	**	85.2
MCC-CMC Interaction	*	0.8
MCC-Temp. Interaction	n.s.	-
CMC-Temp Interaction	**	0.7
3-Factor Interaction	n.s.	-
Not Accounted for	-	0.1

*p> 0.05 **p> 0.01 n.s.-not significant

Table 25. Correlation coefficients (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 8.

Correlation Factors	r	d.f.
Draw Temp/Percent Overrun	.0.736**	35
Percent Overrun/Percent Melt Down	0.711**	35

** p> 0.01
0.418

Table 26. Combinations of microcrystalline cellulose (MCC) and gelatin used in 9 ice milk mixes. The percent overrun (O.R.) and average percent melt down (M.D.) at draw temperatures of 19, 20, 21 and 22F for ice milks tested for experiment 9.

% Gelatin	Parameters Measured	% MCC 0.0 DRAW TEMPERATURES 19	20	21	22	1.3 DRAW TEMPERATURES 19	20	21	22	1.5 DRAW TEMPERATURES 19	20	21	22
0.0	% O.R.	36.7	29.5	41.9	27.2	31.8	35.7	36.7	39.8	26.3	33.3	36.4	38.5
	% M.D.	14.1	10.1	18.6	19.4	11.5	14.7	18.9	24.5	9.8	13.0	15.7	17.9
0.3	% O.R.	35.5	38.1	38.1	37.0	37.0	37.0	40.0	47.6	27.6	39.1	30.3	42.3
	% M.D.	15.9	20.1	17.4	20.6	11.8	15.1	15.8	13.9	8.2	11.7	13.6	14.4
0.5	% O.R.	39.2	37.2	42.4	42.4	35.0	37.0	41.2	51.0	35.0	37.0	41.2	51.0
	% M.D	8.6	13.1	12.3	13.8	4.6	6.6	8.7	14.3	8.1	9.9	13.6	14.7

Table 27. Analysis of variance and percentage of variation for the effect of microcrystalline cellulose (MCC), gelatin and draw temperature (F) on the melt down of ice milks tested for experiment 9

Source of Variance	Analysis of Variance	Percentage of Variation
Levels of MCC	**	16.6
Levels of gelatin	**	48.1
Draw Temperature	**	30.2
MCC-Gelatin Interaction	**	3.9
MCC-Temp. Interaction	n.s.	-
Gelatin-Temp. Interaction	**	1.1
3-Factor Interaction	n.s.	-
Not Accounted For	-	0.1

**p> 0.01 n.s. - not significant

Table 28. Correlation (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 9.

Correlation Factors	r	d.f.
Draw Temp/Percent Overrun	0.508**	35
Percent Overrun/Percent Melt Down	0.119 n.s.	35

** $p > 0.01$ 0.418

n.s. - not significant

Table 29. Combinations of microcrystalline cellulose (MCC) and algin used in 9 ice milk mixes. The percent overrun (O.R.) and average percent melt down (M.D.) at draw temperatures of 19, 20, 21 and 22F for ice milks tested for experiment 10.

% Algin	Parameters Measured	%MCC											
		0.0				1.3				1.5			
		DRAW TEMPERATURE				DRAW TEMPERATURE				DRAW TEMPERATURE			
		19	20	21	22	19	20	21	22	19	20	21	22
0.0	% O.R.	36.7	29.5	41.9	27.2	32.6	36.4	38.4	39.9	34.2	36.4	38.1	35.0
	% M.D.	14.1	10.1	18.6	19.4	16.6	17.1	22.4	24.4	15.6	19.7	17.5	19.5
0.3	% O.R.	36.0	37.0	41.1	41.7	21.6	34.5	39.2	39.2	28.9	31.1	38.9	47.1
	% M.D.	15.7	21.0	25.3	27.9	12.8	16.2	15.5	20.3	13.2	12.7	15.2	24.7
0.5	% O.R.	27.2	36.7	43.1	45.4	30.0	30.4	42.4	40.4	29.9	20.7	24.2	16.1
	% M.D.	11.7	13.8	22.0	24.3	14.9	18.0	20.6	26.7	14.3	11.4	14.4	22.2

Table 30. Analysis of variance and percentage of variation for the effect of microcrystalline cellulose (MCC), algin, and draw temperature (F) on the melt down of ice milks tested for experiment 10

Source of Variance	Analysis of Variance	Percentage of Variation
Levels of MCC	**	20.7
Levels of Algin	n.s.	-
Draw Temperature	**	68.0
MCC-Algin Interaction	**	8.4
MCC-Temp. Interaction	**	1.5
Algin-Temp Interaction	*	1.1
3-Factor Interaction	**	0.3
Not Accounted For	-	0.1

*p> 0.05 **p> 0.01 n.s. - not significant

Table 31. Correlation coefficients (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 10.

Correlation Factors	r	d.f.
Draw Temp./Percent Overrun	0.509**	35
Percent Overrun/Percent Melt down	0.585**	35

*p> 0.05
0.325

**p> 0.01
0.418

Table 32. Combinations of corn syrup solids (CSS) used to replace 25 percent of the sucrose in 6 ice milk mixes. The percent overrun (O.R.) and average percent melt down (M.D.) at draw temperatures of 19, 20, 21 and 22F for ice milks tested for experiment 11.

	% Of Total Sweetener As Corn Syrup Solids																							
	CSS-15 0.0 CSS-24-924 0.0				CSS-15 0.0 CSS-24-924 25.0				CSS-15 25.0 CSS-24-924 0.0				CSS-15 18.73 CSS-24-924 6.27				CSS-15 12.5 CSS-24-924 12.5				CSS-15 6.27 CSS-24-924 18.73			
	°F DRAW				°F DRAW				°F DRAW				°F DRAW				°F DRAW				°F DRAW			
Parameters Measured	19	20	21	22	19	20	21	22	19	20	21	22	19	20	21	22	19	20	21	22	19	20	21	22
% O.R.	38.7	44.6	50.4	53.4	42.5	40.9	42.5	45.8	37.8	37.3	40.4	35.3	34.9	39.0	40.5	41.1	37.8	35.8	39.4	41.5	36.5	37.0	35.0	42.3
% M.D.	20.0	25.4	23.3	33.8	22.8	24.3	26.8	30.2	20.2	19.6	23.2	32.6	21.4	21.0	25.0	25.3	21.2	22.8	27.7	26.9	18.3	21.5	24.0	26.3

Table 33. Analysis of variance and percentage of variation for the effect of sweetener combinations and draw temperature (F) on the melt down of ice milks tested for experiment 11.

Source of Variance	Analysis of Variance	Percentage of Variation
Sweetener Combinations	**	6.6
Draw Temperature	**	92.4
Interaction	**	1.0
Not Accounted For	-	0.1

**p> 0.01

Table 34. Correlation coefficients (r) for draw temperature, percent overrun and percent melt down of ice milks tested for experiment 11.

Correlation Factors	r	d.f.
Draw Temp./Percent Overrun	0.441*	23
Percent Overrun/Percent melt down	0.512**	23

*p 0.05
0.396

**p 0.01
0.505

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The effect of stabilizer and emulsifier combinations, position size, type of fat, amount of fat, level of serum solids, level of sucrose, combinations of sucrose and corn syrup solids and draw temperature, on the melt down of soft serve ice milk tested under constant conditions was evaluated. A large portion size and low draw temperature caused a low melt down, whereas, increasing the levels of milk solids-not-fat and sucrose caused an increased percent of meltdown. The other factors studied generally showed a lesser effect on the melt down when the percentage of variation was computed.

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Stabilizers (Agents)	6					
Emulsifying Agents	6					
Amount	6					
Fats	6					
Sucrose	6					
Glucose	6					
Corn Syrup Solids	6					
Temperature	6					
Drawing	6					
Melting	7					
Ice Cream	7.9					
Ice Milk	7.9					